

## **Chapter 7**

### **Field Analysis**

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## Chapter 7

### Field Analysis

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#### 7.1 Introduction

The New Jersey Department of Environmental Protection (NJDEP) is committed to streamlining the site investigation and remediation process at contaminated sites. This chapter of the Field Sampling and Procedures Manual was developed primarily in an effort to expedite the delineation phases of site investigation by providing a means for improving the quality of field analytical data. One way to implement expedited site investigation is through the use of the Triad approach, and more information on this process may be found in Chapter 1.2 of this Manual.

The site investigation shall follow the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, which places emphasis on laboratory analytical methods. However, field analytical methods may be employed if sufficient documentation can be provided to the NJDEP to support the proper application of the method. Persons wishing to use a field analytical method shall submit the proposal to the project team for approval.

With incorporation of the Field Analysis Manual (1994) into the Field Sampling Procedures Manual, field analytical methods are no longer included; however, this section now incorporates by reference several services for finding appropriate field analytical methods.

#### 7.2 Application of Field Analytical Methods

Field-portable instrumentation provides useful information for critical decisions in the field. Typical application of field analytical methods include the following:

- Emergency response, Health, Safety and Industrial Hygiene, and Fence Line Monitoring to determine possible exposure of the community and of personnel
- Source/Process Monitoring – determines regulatory compliance-related monitoring of stack emissions or effluent discharge
- Odor Investigation – a portable gas chromatograph/mass spectrometer (GC/MS) will permit a full analysis for unknowns and leak detection (source detection), a portable gas chromatograph (GC) will permit analysis of suspected contaminants
- Site Characterization/Remediation/Brownfields – Field portable instrumentation/method is well suited to implement dynamic sampling plans in which the goal is to perform a rapid characterization with only a few mobilizations

Almost all projects require screening or semi-quantitative data during the field-screening phase of the site investigation. For example, headspace gas chromatography (GC) can be simple and fast for the analysis of VOCs in soil and water samples during underground storage tank removal or well installation and monitoring. Enzyme kits can provide rapid detection of polychlorinated biphenyls (PCBs) or explosives during site characterization.

Many advances have been and are continuing to be made in the development of field-portable instrumentation. Many of these instruments are hand-held, rugged, and offer very rapid results in the field. Field portable instruments include GCs, micro-GCs, GC/mass spectrometers (MS), extractive Fourier transform infrared (FTIR) spectrometers, filter-based and other infrared (IR) spectrometers, X-ray fluorescence (XRF) spectrometers, and selective monitors in addition to continuous flame ionization detectors (FIDs) and photoionization detectors (PIDs).

### **7.3 Field Analytical Techniques**

Field analyses can be divided into two categories: real time and “near” real-time measurements. Real-time measurements provide instantaneous analysis without the need for sample treatment. Examples include ion-selective electrodes, fiber optic sensors, hand-held gas monitors, direct measuring GCs and portable in-situ XRF instruments.

Near real-time measurements typically include some sample pretreatment prior to analysis of samples. These techniques include wet chemical and enzyme immunoassay kits; GC with a variety of non-specific detectors such as PID and FID; class-selective detectors such as electron capture (ECD for PCBs and chlorinated pesticides) and; compound-specific detections by mass spectroscopy (MS for identification of individual organic compounds). Total petroleum hydrocarbon (TPH) analyzers; inductively coupled plasma/optical emission spectroscopy (ICP/OES); ex-situ XRF; and anodic stripping voltammetry for metals analysis round out examples of these instruments/techniques. The size and experimental operating features determine whether they are classified as field portable or transportable (laboratory-grade) instruments. For example, portable GCs are typically small in size, can use batteries but may not have temperature programming (therefore, operates isothermally) or have slow temperature program ramps from ambient to 200 degrees centigrade. In either case, these GCs are best suited to qualitative analysis of VOCs. In contrast, laboratory-grade GC/MS instruments require a generator or a line voltage power source but can produce quantitative analysis of VOCs and semi-VOCs in the field. Field GC/MS can provide the necessary measurement sensitivity, precision, and accuracy to meet most site-specific data quality objectives (DQOs). However, in many instances, rapid screening GC with ECD/FID or MS is sufficient for VOC soil and water analyses to determine vadose zone and ground water contamination profiles.

### **7.4 Specific Advantages of Field Analysis**

The main advantage of field analysis is that it allows for the performance of rapid characterization with only a few mobilizations via a dynamic sampling plan.

An unique advantage that is offered by field analysis is dedicated analysis of the field samples with the associated QC samples. Often in a batch of 20 samples in a laboratory, a small number of samples (e.g. three samples) from the site of interest are processed with other unrelated samples and the QC samples (e.g. matrix spike samples) may not be one of the site samples. Therefore, the DQO that requires the quality assurance project plan (QAPP) to be based on the very specific needs of each site is served well or often better by dedicated field analysis. Also, due to a rapid turn-around time, the sample integrity of a properly collected and stored one-hour-old sample is often better than that of a sample held for 14 days.

### **7.5 Selection of a Field Analysis Method**

The selected field analysis method must demonstrate method detection limits below the action level or levels of concern (e.g. EPA’s soil screening level or NJDEP’s soil cleanup criteria) for the medium. To insure that the field analytical instrumentation and methods selected are amenable to a given site, site-specific method detection limit studies using soil from the site is recommended. This will help to determine whether matrix interferences or target compounds mask (e.g. portable GC) or cross-react (e.g. enzyme kits) with targeted organics. For further information, please refer to the section titled, *Choosing Appropriate Field Analytical Methods for Contaminant Investigation*.

## 7.6 Factors To Be Considered For Field Analyses

To be “effective,” the field data generated must be of sufficient quality, with respect to measurement precision or reproducibility, accuracy, sensitivity, and have good correlation with the standard laboratory methods to support the objective of the site investigation or cleanup and the DQO. Several factors to be considered before mobilization include the following (the factors are not intended to be all inclusive):

- The action levels for field decisions shall be established as part of the DQOs.
- The project objective shall permit screening and semi-quantitative data in addition to quantitative data to meet DQO.
- The percentage of samples to be analyzed in the field as well as sent off-site for laboratory confirmation shall be determined.
- The methodology to compare field and laboratory data shall be established, for example using duplicate (field duplicate samples) and/or performance evaluation samples in addition to initial and daily calibrations.
- For the field instrument or the analytical method, the measurement selectivity, sensitivity, precision, accuracy, representativeness and action levels shall be determined.
- The standard operating procedures and method detection limit studies are completed before mobilization to evaluate matrix interferences that might be associated with a particular field technology.
- If applicable, the field technician performing the analyses shall have proof of training by the manufacturer/vendor of the test method.
- If sample preservation is required, samples shall be preserved in the field immediately after collection according to the method specific table in chapter two of this document.

## 7.7 Role of Field Screening/Analytical Methods According to the NJDEP Technical Requirements For Site Remediation, N.J.A.C. 7:26E

The field analytical methods for expedited site characterization (ESC) shall operate within the framework of existing regulatory programs of NJDEP. Therefore, screening quality data, e.g. enzyme kits, generated shall be verified by more quantitative analytical data.

A site characterization and/or investigation shall follow the Technical Requirements for Site Remediation, N.J.A.C. 7:26E. The role of field screening methods defined by N.J.A.C. 7:26E, section 2.1(b) is as follows:

- For delineation when the contaminant identity is known or if there is reasonable certainty that a specific contaminant may be present (for example, benzene, toluene, ethylbenzene, xylene in the case of sampling for a gasoline release); or
- To bias sample location to the location of greatest suspected contamination.

Laboratory data is not one hundred percent accurate, but currently represents the best estimate of the true concentration of a contaminant in an environmental sample. Therefore, a comparison of field and laboratory data is required to provide some guidance on the validity of the field data.

According to N.J.A.C. 7:26E 2.1 (b), field screening methods shall not be used to determine contaminant identity or clean zones. However, if satisfactory technical justification is provided, a variance may be approved on a case by case basis. For example, where ten or more samples are required for

initial characterization for an area of concern (AOC), field screening methods may be used to document that up to fifty percent of the sampling points are not contaminated i.e., “clean” or below the cleanup criteria. Any person responsible for conducting characterization and/or remediation may petition the Department for a variance from the frequency requirements in accordance with N.J.A.C. 7:26E-1.6(d). These variance petitions shall provide technical justification and will be evaluated by the Department on case by case basis.

For a variance application, technical justification may include: knowledge of the contaminant, lack of or minimal matrix effect, lack of or minimal interfering constituents, capability to produce qualitative and quantitative data using standard calibration and QA/QC practices (e.g. using a Field GC/MS), project-specific audits where a NJDEP staff visits the site during the field sampling/analyses to verify that the standard operating procedure (SOP) and QAPP is followed, and the field strategy has been accepted as an ASTM Standard Practice or the technology has been independently verified.

When volatile organic contamination is suspected in soils, initial characterization for soils during preliminary assessment and site investigation, for both field and laboratory analyses shall be performed according to N.J.A.C. 7:26E-3.6.

The number of sampling locations at each contaminated and/or non contaminated area as well as depth of the samples at each location shall be determined and reported for all contaminants of concerns (COCs).

## **7.8 Regulatory Initiative For Development of Field Analyses**

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New third party technology verification programs are involved in evaluating, reviewing, or endorsing new and innovative field testing technologies. One such technology verification program is the EPA’s Environmental Technology Verification (ETV) program. Related programs include the EPA Site Characterization and Monitoring Technology, also known as the Consortium for Site Characterization Technology (CSCT), and Cal/EPA’s Certification Program.

Interstate initiatives such as the Interstate Technology & Regulatory Cooperation (ITRC, which currently has 43 member states) are in place to review and promote innovative technologies. The ITRC group publishes guidance documents on new technologies for environmental applications. The ITRC/ASTM partnership for accelerated site characterization, in Appendix G of their FY-97 summary report, delineated detailed guidelines on *Practice for Expedited Site Characterization of Vadose Zone and Ground Water Contamination at Hazardous Waste Contamination Sites*.

Several new characterization and assessment strategies have been cited in a recent EPA publication *Summary of Recent Improvements in Methods for the Study of Contaminated and Potentially Contaminated Sites*, published by the Technology Innovation Office (TIO). The strategies endorse the use of field methods for quick turnaround information for on-site decision making.

All of the above programs/agencies provide test results and report on a technology’s performance or permitting protocols. However, any new technology selected or adopted shall follow good QA/QC practices for verification.

Individual training programs such as DOE’s ESC Training Course, Argonne National Laboratory’s Quick Site™ Course and EPA’s Field-Based Site Characterization Technologies and Strategies for Field-Based Analytical and Sampling Technologies Courses are available. These as well as vendor provided courses offer information to keep abreast on the developments in this expedited site characterization area.

Currently, the following two strategies have been accepted as ASTM Standard Practices: Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases (PS3-95) and ESC of Hazardous Waste Contaminated Sites (D6235-98). In the future, as sophisticated analytical instruments are being miniaturized, more field-based technologies are likely to become standard practices.

## 7.9 Choosing Appropriate Field Analytical Methods For Contaminant Investigation

The universe of field analytical methods has grown significantly and the accuracy of the methods has increased dramatically since the NJDEP initially developed the *Field Analysis Manual* in 1994. The NJDEP determined that inclusion of individual field analytical methods in this chapter of the Field Sampling Procedures Manual is not practical and not necessary considering the number of useful web sites dedicated to field analytical methods. Therefore, this section provides a guide to using web sites to identify appropriate field analytical methods, gather information regarding these methods and present this information to the NJDEP in an acceptable format.

### 7.9.1 Considerations Prior To Researching Field Analytical Methods

Field analytical methods can provide accurate results instantaneously or within a short period of time; however, the field analytical method chosen must be appropriate for the analytes of concern and site conditions. When choosing a field analytical method, the first consideration should be to determine what analytes of concern are present on the site (i.e. PAHs, PCBs, metals, etc.) and what level of detection (i.e. low ppb, mid ppm, etc.) must be achieved in order to reach the goals established in the QAPP. Most web sites will provide a search engine allowing for a search of methods specific to an analyte or group of analytes or will provide information indicating which methods are appropriate for an analyte or set of analytes. These web sites will generally also provide typical detection limits for each method.

**7.9.1.1 Matrix Effects:** The matrix or matrices (i.e. soil type, sediment, water, etc.) may cause one field analytical method to be preferable to another, or may cause interference in an analytical method. An example of matrix effects is extremely fine clays, which may cause an immunoassay test to be biased low. Another example of matrix effects is the presence of large pebbles, which may render it difficult to use an XRF efficiently, as a flat, relatively uniform, surface is required for analysis (this problem may be solved by sieving the soil prior to analysis). Some field analytical methods require extraction or other sample preparation methods and therefore, are not amenable to using with certain matrices. Knowledge of the unique characteristics of the site matrices will permit identification of potential interferences due to matrix effects. Concentrations of elements in different types of soil or matrices might change, causing interferences (i.e. between arsenic and lead). Site-specific calibration can compensate for some of those effects.

**7.9.1.2 Analyte(s) of Concern:** The field analytical method chosen must be capable of detecting the analyte or analytes of concern at the site. Unlike most laboratory methods, which detect suites of analytes providing quantitation for each of the individual analytes, many field analytical methods detect only individual analytes or groups of analytes, without providing quantitation for each of the individual analytes. Several field analytical methods (i.e. XRF, Field GC, etc.) can analyze a suite of analytes and provide quantitation for each individual analyte; however, these methods must be calibrated for each analyte of concern. Several field analytical methods can be used in conjunction to determine an array of analytes or cross-reference a common analyte. The objectives in the QAPP will determine which field analytical methods



will be employed at the site. If a number of similar analytes are present at a site, it may be difficult to quantify certain analytes accurately because interference may create false positive results. Results obtained by some field analytical methods (i.e. indicator tubes) are qualitative to semi-quantitative at best. The minimum detection limits for some field analytical methods are influenced by factors such as water vapor and chemical interference.

7.9.1.3 Interfering Constituents: Another item to consider, prior to researching a field analytical method, are other constituents present on the site. Other constituents, even those not regulated or below regulatory limits, may cause interference with the chosen field analytical method. An example of interference is high iron levels, which are below regulatory levels, may raise the detection limit for other metals with low regulatory limits when using an XRF for field analysis. Familiarity with other site constituents prior to researching a field analytical method will permit quick identification of possible interference. Some field analytical methods (i.e. field GC) may experience coelution of analytes which may cause biased high results, false positives or make quantification difficult or impossible.

7.9.1.4 Limitations: All analytical methods (fixed laboratory methods, field analytical methods, etc.) have limitations. Understanding these limitations will help to apply the technology properly to generate data that meets the needs of the project. Some methods may not perform well for certain groups of analytes (i.e. petroleum hydrocarbon [immunoassay] methods may not perform well for motor oil or grease, or for highly degraded petroleum fuels) and therefore, these methods may have a potential for false negative results. Some reagents may require refrigeration and, therefore, it may be necessary to have a cooler or refrigerator on site. While analysis with some field analytical methods can be accomplished quickly, it can be time-consuming to perform analyses with other field analytical methods. Certain instrumentation operation (i.e. field GC) requires a higher degree of expertise than most other field analytical methods. Some field analytical methods may require judgement made by the operator (i.e. color comparison to a chart) which can lead to inaccurate results. Some field analytical methods may require that the specific analyte to be tested must be known, so that the method can be calibrated correctly. Some field analytical methods may have no true field-portability, with a mobile laboratory setup required or an electrical power source required. Some field analytical methods may be cost prohibitive on small-scale projects, or a specific license may be required to operate certain instruments (i.e. XRF).

7.9.1.5 Physical Conditions: Physical conditions on site may cause logistical problem with certain field Physical analytical methods (i.e. space limitations, flat surfaces, dry surfaces, etc.) or may cause interference with the field analytical methods (i.e. heat, cold, excessive sunlight, etc.). Examples of logistical problem would be providing enough room with a relatively flat surface in an up wind location for a field GC. Extreme temperatures will effect most field analytical methods and excessive sunlight may cause some reagents to break down. Familiarity with the site conditions will permit a determination of whether a given field analytical method is viable at a particular site.

## 7.9.2 Searching the Websites

Once the analyte(s) of concern are determined, other constituents present at the site have been ascertained and the site matrix (matrices) and physical conditions are known, an internet search to determine an appropriate field analytical method can be performed. Several Internet sites including <http://fate.clu-in.org/index.htm>, <http://www.epareachit.org/index3.html>, <http://www.frtr.gov/> and <http://www.clu-in.org> are good references to begin determination of what field analytical method(s) will be appropriate. In addition, many vendors provide web sites



for their products. Whereas vendor web sites are good sources of information, research from an independent review of the field analytical method is advisable. Each Internet site has a unique way to begin a search.

7.9.2.1 FATE: The Field Analytical Technologies Encyclopedia (FATE) site lists field analytical methods by method. The web site then details under each method the list of appropriate analytes and matrices, what interferences and limitations are associated with the method, typical detection limits, and physical limitations of the field analytical method as well as links to other related web sites.

7.9.2.2 EPAREACHIT: The EPA REmediation And CHaracterization Innovation Technologies (EPAREACHIT) site provides a search engine to select analytes or groups of analytes, matrices and whether the technology has previously been used at a pilot scale, full scale or bench scale. The site then provides detailed information about the technology and links to other related sites.

7.9.2.3 FRTR: The Federal Remediation Technologies Roundtable (frtr) site provides case studies where site characterization technologies were used. The site lists advantages of the methods employed as well as a section on lessons learned during the case study. The site includes the *Field Sampling and Analysis Technologies Matrix and Reference Guide*.

7.9.2.4 CLU-IN: The clu-in site includes the Vendor Field Analytical and Characterization Technologies System (Vendor FACTS). This website has links to relevant “performance based” site characterization and clean up information. Vendor FACTS is a Windows™ based database of innovative technologies for site characterization available for registered users.

When utilizing one of these web sites or any other web site, it is important to identify as many different field analytical methods applicable to the site as possible along with the advantages and disadvantages of each in order to determine which method will best meet the objectives identified in the QAPP. Links to vendor sites are useful, but while providing worthwhile information, may impart a bias to a particular method or instrument. When considering the advantages of a field analytical method, it is always important to consider the site matrices, analytes of concern, potential interferences and limitations of the field analytical methods. In addition, practicality and cost of the field analytical method should be considered for each phase of the site work. A field analytical method may be practical and cost effective for the delineation phase, but may not be practical or cost effective for the remedial phase if laboratory analysis will be required for a percentage of the sample points.

### 7.9.3 Listing Limitations and Interferences for Selected Field Analytical Methods

All analytical techniques have limitations and interferences, including methods used at a fixed laboratory; however, limitations and interferences do not preclude these methods from providing useful information. A thorough understanding of the field analytical method's limitations and interferences as related to the site can define the usefulness of the method and data produced by that method. The limitations and interferences should be presented to NJDEP when initially requesting approval for the use of a field analytical method. In addition to listing the limitations and interferences, ways of compensating for these limitations and interferences or reasons why they will not interfere with the objectives of the QAPP for a given phase of the investigation of the site should be listed.

7.9.3.1 Matrix Effects: Sample matrix interference may not be easily resolved, dependant on the method of interference caused by the matrix (i.e. difficulty extracting from large pebbles); however, sometimes the method will provide a way of correcting the interference through site

specific calibration or altering the sample preparation method. When there is no method to compensate for matrix interference, then the field analytical method may be rendered useless at the site or may only be useful for gross contaminant delineation. When the method; however, can be adjusted or adapted to compensate for matrix effects, then, with NJDEP approval, the field analytical method can be used for finer delineation dependant on the objectives of the QAPP. When requesting use of field analytical methods for delineation at a site, all possible matrix interferences should be listed along with methods for compensating for the matrix interference, if applicable.

**7.9.3.2 Analytes:** Some field analytical methods analyze for general classes of analytes, while others analyze for specific contaminants. Several field analytical methods can be used to test for more than one analyte. Some field analytical methods are designed for classes of analytes (i.e. PAHs, carcinogenic PAHs, BTEX, etc.), and will provide a concentration of the total class of analytes, but will not indicate the concentrations of individual analytes. Some field analytical methods that analyze for one analyte also will respond in various degrees to other related analytes (i.e. immunoassay for PCP will respond to other chlorophenols). Some field analytical methods may provide quantitative results, semi-quantitative results, or qualitative results. Dependant on the objectives specified in the QAPP, any of these types of results may be acceptable for certain phases of the project. All analytes, groups of analytes and detection limits should be listed with an explanation of how these results will satisfy the objectives in the QAPP for each phase of the investigation.

**7.9.3.3 Interfering Constituents:** When interfering constituents are present on the site, generally the method cannot be altered to compensate for the interference. When the interfering constituent still allows analysis of the analyte of concern to be performed, but with a higher detection limit, then the field analytical method may still be valid for the site, but in a limited capacity. Although the field analytical method may not be appropriate for site closure purposes or final delineation, the field analytical method may still be a valuable tool in early delineation rounds of gross contamination. The way in which the field analytical method will be employed at the site will determine whether interfering constituents preclude the method's use at a given site. A list of interfering constituents, their effect on the analyte(s) of concern, and how this relates to the objectives of the QAPP should be presented.

**7.9.3.4 Limitations:** Some field analytical methods may not perform well for certain groups of analytes, may have a potential for false negative results, require refrigeration, be time-consuming, require a high degree of expertise, require judgement made by the operator, have no true field-portability, or may be cost prohibitive on small-scale projects. These limitations should be listed along with an explanation of how they relate to the objectives specified in the QAPP.

**7.9.3.5 Physical Conditions:** If the site is not amenable to conditions needed for a field analytical method, then the method cannot be utilized at the site. However, if an adjacent property provides the right physical conditions and can be utilized and the samples can be collected on the site and transported to the adjacent property, then the method may be viable for the site. A site building or a vehicle brought on to the site may often be utilized to provide the right site conditions such as controlling the amount of sunlight, temperature, humidity, etc. or by providing a space free of site vapors and dusts with large flat work surfaces. Generally physical constraints can be overcome; however, the cost and practicality may preclude this from being a viable option. The restricting physical conditions should be listed along with the resolution of these conditions and how they relate to the objectives specified in the QAPP.

## 7.10 Quality Assurance Project Plan (QAPP) For Implementation of Field Analytical Methods

This section defines the NJDEP Site Remediation Program's Data Quality Levels for contaminant investigation. The type of data required depends on the decision to be made. There are four types of data that can be used to support different types of decisions. To guide in the selection of field analysis methods, a contaminant investigation plan shall meet the minimum data quality standards prior to receiving approval. The project team is responsible for the review and revision of all field analytical proposals.

- Preliminary or Field Screening Data – (Data Quality Objective Level 1): These data are described as screening data. The analyses use field portable instruments. Results often are not compound specific and not quantitative, but results are available real time. The key feature is that additional confirmatory analysis of the same samples is usually required with respect to the decision to be made.
- Effective Data or Field Analysis Data – (Data Quality Objective Level 2): These data are generated by more sophisticated portable analytical instruments and the instruments are capable of generating effective data. The term effective or acceptable data quality is meaningful only when the intended uses for the data are established. Therefore, the goal is to generate the quality data required to accomplish the DQO of the project. Depending on the objective that may or may not mean laboratory quality data. The quality of the data depends on the use of suitable calibration standards, reference material, and sample preparation equipment and the training of the operator. Results are available real time or within several hours.

The data is “effective” also when a portion (10 percent or more) of the results are substantiated or verified by off-site analysis using EPA-approved methods. The effective data are adequate or effective for the intended use (usually because associated quality control is sufficient to inspire confidence). For example, a site has been characterized well enough that the identities of the contaminants are known, and “yes or no” decisions about categorizing waste piles must be made. The analytical tool selected may be known to cross-react with a range of analytes, but, because it is known (from previous confirmatory investigation) that those interferences are not present, the tool is acceptable for support of the “yes or no” decision without confirmatory analysis by another method.

The field analytical methods shall provide data of sufficient quality to meet the data quality objectives. Supporting quality assurance (QA) and quality control (QC) procedures shall be provided to document data quality (please refer to the QA and QC sections for details).

As previously stated, according to N.J.A.C. 7:26E-2.1(b), field screening methods are generally not to be used to determine contaminant identity or clean zones. However, where ten or more samples are required for initial characterization for an area of concern and a variance is approved by the NJDEP, field analytical methods (as opposed to field screening methods) may be used to document that up to fifty percent of the sampling points are not contaminated.

- Meticulous or Definitive Data – (Data Quality Objective Level 3): These data are generated by a method that determines the identity and the concentration of the analyte with “reasonable” certainty. These data can stand on their own with respect to the vast majority of possible decisions.

The meticulous or definitive data are generated from an approved laboratory method and contain QA/QC deliverables as required in N.J.A.C. 7:26E, Appendix A. These data can be used for clean zone confirmation and for delineation during the remedial investigation.

- State-of-the-Art” Data: Special “state-of-the-art” methods may be developed specifically for a particular site, and would be approved on a case by case basis.

## **7.11 Quality Assurance Requirements**

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### **7.11.1 Preliminary or Field Screening Data (Data Quality Level 1)(See Table 7.1.)**

- 7.11.1.1 Field screening data are intended to be used for Health & Safety, initial contaminant screening and/or contaminant delineation (i.e. approximation of contaminated zone).
- 7.11.1.2 Instruments used for field screening data include PID survey instruments, FID survey instruments and XRF with remote probe (x-met). Methods used for Field screening data include hydrophobic dye test, colorimetric analysis and headspace analysis.
- 7.11.1.3 The data produced by field screening shall only be considered an indicator of contamination. Quality control procedures and deliverable requirements are limited to a brief method review, instrument calibration, maintenance logs, field logs, reported data values and background levels.
- 7.11.1.4 Field screening data are real-time, but are semi-qualitative and semi-quantitative, and measurements may be erratic. Therefore, data shall only be used for health and safety and to guide sample placement for analysis by higher level methods.
- 7.11.1.5 Since relatively few quality control procedures are employed compared to higher-level field methods, data quality is very much a function of sample handling techniques and analyst skill.

### **7.11.2 Effective Data or Field Analysis Data (Data Quality Level 2)**

- 7.11.2.1 Effective Data or Field Analysis Data are intended to be effective for the end use and to provide reliable, rapid, contaminant delineation.
- 7.11.2.2 Effective Data or Field Analysis Data can achieve a high degree of reproducibility when required QA/QC procedures are employed.
- 7.11.2.3 Field analysis methods are typically laboratory methods, which have been adapted for field use (i.e. field GC, portable XRF, field IR).

In addition to screening data requirements, quality assurance (QA) deliverables shall include:

- Initial calibration curves
- Continuing calibration curves (1 per 10 samples)
- Field Duplicates (1 per 20 samples)
- Background/Blank data
- Analyses Run Log
- Raw data submission (i.e. chromatograms, recorded instrument readouts, etc.)
- Chain of Custody Documentation (or field sample tracking sheets)
- Non-conformance summary listing all deviations from the approved SOP and QA/QC parameters outside control limits. The non-conformance summary shall include an analyst certification statement.

- Laboratory confirmation data shall be submitted along with the field analytical data. At a minimum, if a variance is approved, 10% of all Field analysis data shall be laboratory confirmed (both clean and contaminated samples). As stated before, N.J.A.C. 7:26E-2.1(b) require that 50% of all “clean” samples be laboratory confirmed during the site investigation and 100% of all “clean zone” samples be laboratory analyzed/confirmed during the remedial investigation. A variance from these requirements may be requested pursuant to N.J.A.C. 7:26E-1.6(d) with technical justification.
- The laboratory performing the confirmation analyses using a standard method (e.g. a SW846 method or a CLP method) must be certified to perform the analyses.
- Results of analyst competency tests (i.e. performance evaluation tests and proof of training) are required.
- Matrix Spike Recovery (case-by-case)
- Surrogate Analyte Analysis (case-by-case)
- Method Blank Analysis (case-by-case)
- Quality Control Check Sample Analysis (case-by-case)

7.11.2.4 Field analysis data may be semi-quantitative (i.e. providing an estimated value) and semi-qualitative or class specific (definitive contaminant identification is not provided).

7.11.2.5 Environmental samples frequently contain contaminants of unknown identity and concentration. Laboratory data, although not one hundred percent accurate, currently represents the best estimate of the true concentration of a contaminant in an environmental sample. Therefore, a comparison of field and laboratory data can help to provide some guidance on the validity of the field data.

A laboratory-field correlation of Field Analysis data has two components and can be calculated by the following regression analysis equation:

$$L = xF + y$$

where:

L = the reported laboratory concentration of a contaminant

F = the reported field concentration of the same contaminant

x = the slope of the correlation of field and laboratory data

y = the intercept of the field and laboratory data (constant)

R squared = fit of equation

The two components of the laboratory-field correlation are: 1) the fit (R squared) and 2) the intercept (y). Given the lack of homogeneity of environmental samples, variation in sample handling and variations inherent in both field and laboratory data, the fit of the equation is not expected to be perfect (i.e. in most cases, R squared  $\neq$  100%); however, R squared and a plot of the scatter graph shall be developed by the data reviewer and submitted to the Department. An examination of the R squared and scatter graph shall be made to determine the usefulness of the field data. Professional judgement shall be used when determining whether field data shall be used for delineation and/or clean samples (with an approved variance).

The intercept (y) is important due to differences in concentrations determined in field verses laboratory data. During the remedial investigation (RI), field based contaminant zone delineation levels may be adjusted per the following equation:

$$C_f = C + y$$

where:

$C_f$  = contamination zone delineation criteria for field generated data

$C$  = cleanup criteria for laboratory data

$y$  = the intercept of the field and laboratory data correlation equation

7.11.2.6 Field Analytical methods also include published laboratory methods such as USEPA SW-846 laboratory methods, which are highly reproducible; however, field analytical data are generally documented using only limited quality assurance deliverables.

7.11.2.7 The quality or effectiveness of Field Analytical data generated using published (laboratory) methods with limited deliverables is a function of sample handling, storage and preservation procedures, and analytical instrument maintenance. These data shall be reliable if proper sampling, analytical, and QC procedures are followed.

#### 7.11.3 Meticulous or Definitive Data (Data Quality Level 3)

7.11.3.1 Final remediation shall be based on the site-specific cleanup criteria using Meticulous or Definitive Data because this type of data is intended to generate the most reliable data practicable.

7.11.3.2 Meticulous or Definitive Data are highly reproducible and can provide the end user with complete QA/QC documentation in accordance with N.J.A.C. 7:26E, Appendix A.

7.11.3.3 Methods that generate Meticulous or Definitive Data are generally the same published laboratory methods as Field Analytical Data but are supported with full laboratory data deliverables or reduced laboratory data deliverables in accordance with subchapter 2 and Appendix A of N.J.A.C. 7:26E.

7.11.3.4 Meticulous or Definitive Data can only be generated by a certified or otherwise approved laboratory pursuant to N.J.A.C. 7:26E section 2.1.

#### 7.11.4 “State-of-the-Art” Data:

7.11.4.1 Generally “State-of-the-Art” methods are developed specifically for a particular site or contaminant.

7.11.4.2 “State-of-the-Art” methods are used when standard laboratory methods are either unavailable or impractical.

7.11.4.3 Data generated using a “State-of-the-Art” method may have variable deliverable requirements. These requirements will be proposed by the laboratory or person performing the analysis and evaluated by the Department for each method proposed. If the method and the deliverables requirements are approved, the data produced by methods conforming to these requirements will be acceptable for their intended use.

7.11.4.4 “State-of-the-Art” methods may be accepted to delineate a contaminant, define a “clean zone” or confirm field data per Item 7.11.4.3, above.



7.11.4.5 Generation of “State-of-the-Art” data may necessitate use of a laboratory, which specializes in methods development.

**Table 7.1 Overview of Data Quality Classifications**

<b>Data Quality Level</b>	<b>Purpose of Sample</b>	<b>Example Methods or Instruments</b>
Screening Data	Health & Safety, Field use when excavating, Contaminant Screening & Delineation	Portable PID, Portable FID, Colorimetric Analysis, XRF with a remote probe (x-met), Headspace Analysis, Hydrophobic Dye Test
Field Analytical Data	Field use when excavating, Contaminant Delineation, Clean Sample Confirmation during SI	Portable GC, Portable IR, Portable XRF with Si(Li), Portable AA, Immunoassay, USEPA SW-846 Field Screening Methods Laboratory Analyzed Samples with Limited QA/QC requirements, {i.e. USEPA SW-846 Laboratory Methods (most recent edition)}
Definitive Data	Delineation, Clean Zone Confirmation	Laboratory Analyzed Samples, with full QA/QC documentation, {i.e. USEPA SW-846 Laboratory Methods (most recent edition)}
State-of-the-art Data	Non-standard method analysis	Laboratory Special Services, Mobile Laboratory

## 7.12 Field Data Deliverables Format

The following requirements can be incorporated into a dynamic workplan and to establish standard operating procedures (SOPs) and the QAPP. SOPs for sample collection and analysis shall be developed with other SOPs required to answer site-specific questions (e.g. geophysical and hydrogeological surveys, etc.). In addition, please refer to the sections on the QAPP and Quality Assurance Requirements of this chapter, and subchapter 2 and Appendix A of N.J.A.C 7:26E.

### 7.12.1 Field-Screening Data – QA/QC Requirements

The following represents the minimum data deliverables required for field screening data. The “Data Deliverables” section of each method will provide specific requirements:

7.12.1.1 A brief method review shall be provided.

7.12.1.2 A single point calibration shall be conducted prior to any field activities using site-specific standards.

7.12.1.3 Calibration checks shall be performed at a minimum of twice daily bracketing the sample analyses. If a calibration check falls outside the manufacturer’s suggested range, then a complete multi-point calibration is required.

7.12.1.4 A baseline or blank scan (i.e. “clean air,” “clean water” or “clean soil” as appropriate) shall be run each day prior to analyzing any site samples.

7.12.1.5 An instrument log shall be maintained and submitted (where appropriate). This log shall include instrument maintenance, blank, and calibration information, *including date, time*, analyst’s name, calibration standard compounds, the concentrations and readings of the calibration standards.

7.12.1.6 Field logs shall document sample ID#, date, time, location, depth, matrix (i.e. soil type, water, air), soil moisture (qualitative estimate where appropriate), and the reading and concentration/result of the analysis.

7.12.1.7 A non-conformance summary shall state all data inconsistencies and all divergences from the approved sampling/analysis program. The implication of all non-conformances shall be clearly explained and quantified (if possible).

**7.12.2 Effective Data or Field Analysis Data – QA/QC Requirements**

In addition to the requirements listed for the field screening data, the following represents the minimum data deliverables required for field analysis Data. The “Data Deliverables” section of each method will provide specific requirements:

7.12.2.1 Each project team that uses a field analysis method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of capability and an ongoing analysis of calibration standards. To establish the ability to generate acceptable accuracy and precision, the analyst shall perform the following operations:

7.12.2.1.1 A soil quality control (QC) check sample. The QC check sample shall be prepared by the laboratory using stock standards prepared independently from those used for calibration.

7.12.2.1.2 An aqueous QC sample, prepared in the same fashion as the soil QC sample, is also required.

7.12.2.1.3 Analyze four aliquots of each of the well-mixed QC check samples according to standard procedures.

7.12.2.1.4 Calculate the average recovery mean (X) and the standard deviation of the recovery (s) for each parameter of interest in each matrix using the four results.

7.12.2.1.5 For each compound, X shall be between 60% and 140% of the true value. Additionally, s shall be  $\pm 40\%$  of X.

7.12.2.2 Method blanks (i.e. syringe blanks, equipment blanks, and instrument blanks) shall be run at the beginning and during each workday or after a sample when carry-over is anticipated. A higher frequency of blank analyses may be required depending upon equipment use and results.

7.12.2.3 Instrument shall be calibrated each month with 3-point or 3-level (minimum) laboratory certified standards and shall also be calibrated daily with 1-mid point or 1-mid level laboratory certified standards. The standard analytes and concentrations shall be chosen based on known site contamination and encompass the range of expected concentrations. Surrogate compounds shall also be included. Matrix-specific minimum detection limits shall be determined and reported for all site-specific compounds.

7.12.2.4 If standard curves remain linear over the entire analysis range, only one midpoint standard shall be analyzed at a frequency of 1 per 10 samples. If standard curves are not linear over the entire analysis range, a minimum of two (2) calibration standards, one low level and one high level standard shall be analyzed at a frequency of 1 per every 10 samples.

7.12.2.5 Matrix Spike and Matrix Spike Duplicate samples may be required at a rate of one per every 20 samples. The project team shall determine if MS/MSD samples are required on a case-by-case basis.

7.12.2.6 Chain of custody or sample tracking documentation shall be generated for all samples collected and analyzed. This documentation shall include a statement certifying that all data were generated following proper procedures.

7.12.2.7 Proof of training for the technician performing the analyses is required.

## 7.13 Data Management Plan

The ability to manage and easily use all of the data produced in the field is critical to the success of the field analysis technologies. Protocols for sample logging, analysis, data reduction, and site mapping shall be established. The data management plan shall be established prior to mobilization for the collection, processing, and presentation of the field generated data. Sample logging information and the results of the analysis can be managed through a Laboratory Information Management System or through the use of spreadsheets. The data can then be downloaded to a computer containing site visualization software for conceptual model update and review.

## References/Resources

NJDEPE *Field Analysis Manual*, July 1994.

NJDEPE *Field Sampling Procedures Manual*, May 1992.

Technical Requirements for Site Remediation, N.J.A.C. 7:26E, Readoption with Amendments February 18, 1997, Latest Amendments, February 3, 2003.

USEPA *Field Analytic Technologies Encyclopedia (FATE)* Web Site: <http://fate.clu-in.org/index.htm>.

USEPA REmediation And CHaracterization Innovation Technologies (EPAREACHIT) Web Site: <http://www.epareachit.org/index3.html>.

USEPA, Dept. of Energy, Dept. of Defense, Dept. of the Interior, Dept. of the Navy, Dept. of the Air Force, Dept. of the Army *The Federal Remediation Technologies Roundtable* Web Site: <http://www.frtr.gov/>.

ITRC/ASTM FY-97 summary reports (Appendix G) *Practice for Expedited Site Characterization of Vadose Zone and Ground Water Contamination at Hazardous Waste Contamination Sites*.

Field Analysis – Breaking down the barriers of Standard Practice; Caroline Purdy and Andrew Paterson, Soil and Groundwater Cleanup December/January 1999.

A guideline for dynamic workplans and field analytics: Albert Robbat, Jr. Center for Field Analytical Studies and Technology.

The Business of Making a Lab Field-Portable by Craig Crome, Environmental Testing and Analysis, November/December 2000.

## Glossary

**Accelerated Site Characterization (ASC)** – A process for characterizing vadose zone and ground water contaminated sites using primarily professional judgement-based sampling and measurements by an integrated, multidisciplinary core technical team. The team operates within the framework of a dynamic work plan that gives flexibility and responsibility to select the type and location of measurements to optimize data collection activities during a limited number of field mobilizations.

**Accuracy** – the ability of a technique to detect the true concentration of the analyte.

**Calibration** – the process by which data can be made to correlate with known standards.

**Certified Laboratory** – a laboratory that is currently certified pursuant to N.J.A.C. 7:18, the Regulations Governing Laboratory Certification and Standards of Performance, to perform laboratory analysis for a specific certification category and a specific parameter within the certification categories.

**Clean Zone** – a series of contiguous samples collected at a frequency consistent with the requirements of the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, which are analyzed and determined to be below the cleanup criteria (a single sample may constitute a clean zone for small contaminated areas).

**Contaminant** – as defined in N.J.A.C. 7:26E, currently: any hazardous substance, hazardous constituent, hazardous waste or pollutant discharged by any individual or entity.

**Contaminant Delineation** – the systematic collection and analysis of samples from a point of known contamination to determine the vertical and horizontal extent of contamination.

**Contaminant Screening** – the analysis of environmental media by non-selective instrumentation or methods to gain a preliminary estimate of contaminant extent.

**Corrected Results** – the results obtained when instrumental results are adjusted to account for laboratory confirmation values and/or other quality control criteria.

**Expedited site characterization (ESC)** – A process for characterizing vadose zone and groundwater contaminated sites using primarily professional judgement, base sampling and measurements by an integrated, multidisciplinary core technical team. The team operates within the framework of a dynamic work plan that gives flexibility and responsibility to select the type and location of measurements to optimize data collection activities during a limited number of field mobilizations.

**Dynamic work plan** – A site characterization work plan including a technical program that identifies the suite of field investigation methods and measurements that may be necessary to characterize a specific site, with the actual methods used and the locations of measurements and sampling points based on on-site technical decision making.

**Field Portable** – an instrument that is durable and relatively simple to move between facilities for on-site analysis.

**Full Laboratory Data Deliverables** – the data deliverables as required in N.J.A.C. 7:26E section 1.8 and Appendix A.

**Instrument Log** – a manual that documents all instruments outputs, calibration, and maintenance.

**Isoconcentration** – more than one sample point exhibiting the same analyte concentration.

**Isopleth** – the line or area represented by an isoconcentration.

**Limited Laboratory Data Deliverables** – data deliverables with less QA/QC documentation than those required under Appendix A of N.J.A.C. 7:26E.

**MDL (method detection limit)** – the minimum concentration of a substance that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the analyte.

**PQL (practical quantitation level)** – the lowest quantitation level of a given analyte that can be reliably achieved among laboratories within the specified limits of precision and accuracy of a given analytical method during routine operating conditions.

**Precision** – the ability of a method to provide reproducible results from sample to sample.

**Quality Assurance (QA)** – documentation designed to assure that proper sampling and/or analysis protocol are being followed. Measures taken to independently check and verify that the quality control procedures specified in the QA/QC plan are being carried out.

**Quality Assurance Project Plan** – a document which presents in specific terms the policies, organization, objectives, functional activities and specific quality assurance/quality control activities designed to achieve the data quality goals or objectives of a specific project or operation.

**Quality Control (QC)** – the implementation of protocols designed to assure that the final sampling or analytical results are reliable. QC is the process of ensuring the quality of data during their collection, measurement, integration, interpretation, and archiving, through the application of defined procedures.

**Reduced Laboratory Data Deliverables** – the data deliverables as required in N.J.A.C. 7:26E section 1.8 and Appendix A.

**Response Factor (Relative Response Factor)** – a measure of the relative response of the instrument detector to an analyte compared to an internal or external standard. Relative Response Factors are determined by the analysis of standards and are used to calculate the concentrations of analytes in samples.

**Semi-Qualitative** – identification of a compound by class rather than identification of the specific compound (i.e. semi-qualitative would identify aromatic hydrocarbons whereas qualitative would identify benzene).

**Semi-Quantitative** – numeric values which only approximate the true concentration of the analytes.

**Site Screening** – rapidly surveying a site, possibly employing some chemical analysis instrumentation or methods, in an effort to estimate worst case environmental conditions.

**Site-similar material** – material containing the same chemical and physical characteristics of native material found on-site and shall include actual site material used for the prescribed purpose.

**Survey Instrument** – an instrument which detects compounds with little or no selectivity.

**Total Recoverable** – the amount of a contaminant that is extracted from the sample.

**Traditional Site Evaluation** – the initial characterization, delineation and clean zone confirmation of a site by collection and analysis of samples by certified methods with appropriate data deliverables.